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IS 8252-2 (1980): Environmental tests for aircraft equipment, Part 2: Temperature, pressure and humidity [TED 14: Aircraft and Space Vehicles]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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Indian Standard

ENVIRONMENTAL TESTS FOR AIRCRAFT EQUIPMENT

PART II TEMPERATURE, PRESSURE AND HUMIDITY

1. Scope — Covers requirements for the climatic tests and test procedures relating to detailed equipment design or requirement standards. This standard permits the selection of specific test conditions and methods that will unambiguously define the climatic acceptance requirements for specific equipment in aircraft.

2. General — This standard details climatic environments against which aircraft equipment should be designed, and also defines climatic tests from which the necessary selection should be made to demonstrate that the equipment will be satisfactory for its operational environments. These functional characteristics do not necessarily determine the life or reliability of the equipment which should be dealt with by the individual relevant equipment specification. Although in practice an almost infinite variety of environmental conditions may be encountered, depending on the class of aircraft and grade of equipment, etc, it is considered highly desirable to group together standardized test conditions which, when applied in a standard sequence, will demonstrate the operational capability of an item of equipment and yet, as an aid to equipment manufacturers, keep the number of grades to a minimum. This Standard contains a schedule, listing the tests and operational environments applicable to various equipment grades.

2.1 This standard is intended to apply to equipment for general aircraft use. However, it may also be used for application to equipment designed for use in specific aircraft. In such cases the relevant individual equipment standards should state what additional tests or amendments to these standard tests are necessary to meet precise requirements.

2.2 Although the tests are shown in the sequence considered to be the most practical and logical, it may not be ideal for a particular test programme. In these circumstances the individual standard should select from this standard the appropriate tests and state the sequence in which the tests are to be applied.

2.3 Information on the basis of climatic temperature levels is given in Appendix A.

3. Definitions — For the purpose of this standard the following definitions shall apply.

3.1 Idle — Isolated from the source or sources of power.

3.2 Operate — To cause an equipment to carry out some or all of the services and functions (as stated in the relevant Standard) for which it is intended.

3.3 Performance — The demonstration in quantitative terms of the function(s) of an equipment to defined requirements.

4. Aircraft Classifications — The classes of aircraft are as follows:

- a) **Class X** — This class includes aircraft with a maximum ceiling of 6 000 m (20 000 ft). It includes helicopters, light aircraft, piston-engined executive aircraft and, in general, all unpressurized aircraft. Typically, these aircraft will use outside air for cooling and have a simple heating system using waste engine heat.
- b) **Class Y** — This class includes most passenger and cargo aircraft having ceilings of 15 000 m (50 000 ft). Certain compartments will be pressurized and/or provided with heating and cooling systems.
- c) **Class Z** — This class includes supersonic aircraft but for the purpose of this Standard is restricted to aircraft having, in the main, light alloy airframes, the temperature limit of which is considered to provide a convenient boundary. This limit is taken as a temperature of 150°C and represents Mach numbers up to about 2.2 in cool ambient conditions. The maximum altitude is likely to be 21 000 m (70 000 ft) with minimum cruising speeds of Mach 0.7 to 0.9.

Note — For aircraft having a performance outside the maximum speeds indicated for Class Z, there is insufficient evidence at present to give detailed temperature environments. Such aircraft would have air frames of heat-resisting material. However, it is not likely that temperature and pressure-controlled zones will differ from Class Z. For unconditioned bays the temperature will depend upon the degree of insulation and flight time. For externally mounted equipment and for equipment in uninsulated bays, maximum temperature will be of the following order:

Mach No.	Temperature
2.5	185°C
3.0	290°C
3.5	415°C

This information is offered for guidance; the aircraft manufacturer should be consulted for more details.

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5. Equipment Categories — The severities for the tests specified in this standard vary according to the category of the equipment; the categories are as described below. These categories in turn relate to the aircraft classifications given in 4. The relationships between the categories and classifications are summarized in Table 1. The test severities for each category are listed in Table 2.

5.1 The specific categories stated below are intended to cover the wide range of environments existing in different types of aircraft and various locations. The test requirements for special categories, if required, shall be stated in the relevant equipment specification.

- a) *Category A1* — Equipment intended for installation in pressurized and controlled temperature locations in aircraft in which the pressures are no lower than that which is equivalent to an altitude of 4 500 m (15 000 ft);
- b) *Category A2* — Equipment intended for installation in pressurized but only partially temperature controlled locations in aircraft in which the pressures are not lower than that which is equivalent to an altitude of 4 500 m (15 000 ft);
- c) *Category B1* — Equipment intended for installation in non-pressurized and controlled temperature locations in Class X aircraft which operate at altitudes up to 6 000 m (20 000 ft);
- d) *Category B2* — Equipment intended for installation in non-pressurized and non-controlled temperature locations in Class X aircraft which operate at altitudes up to 6 000 m (20 000 ft);
- e) *Category B3* — Equipment intended for installation in the power plant compartment of Class X aircraft which operate at altitudes up to 6 000 m (20 000 ft);
- f) *Category C1* — Equipment intended for installation in non-pressurized and controlled temperature locations in Class Y aircraft which operate at altitudes up to 10 500 m (35 000 ft);
- g) *Category C2* — Equipment intended for installation in non-pressurized and non-controlled temperature locations in Class Y aircraft which operate at altitudes up to 10 500 m (35 000 ft);
- h) *Category C3* — Equipment intended for installation in the power plant compartment of Class Y aircraft which operate at altitudes up to 10 500 m (35 000 ft);
- i) *Category D1* — Equipment intended for installation in non-pressurized and controlled temperature locations in Class Y aircraft which operate at altitudes up to 15 000 m (50 000 ft);
- k) *Category D2* — Equipment intended for installation in non-pressurized and non-controlled temperature locations in Class Y aircraft which operate at altitudes up to 15 000 m (50 000 ft);
- m) *Category D3* — Equipment intended for installation in the power plant compartment of Class Y aircraft which operate at altitudes up to 15 000 m (50 000 ft);
- n) *Category E1* — Equipment intended for installation in non-pressurized and non-controlled temperature locations in Class Z aircraft which operate at altitudes up to 21 000 m (70 000 ft); and
- p) *Category E2* — Equipment intended for installation in the power plant compartment of Class Z aircraft which operate at altitudes up to 21 000 m (70 000 ft).

6. General Test Requirements — In addition to the following requirements the standard conditions stated in IS: 8252 (Part I)-1976 'Environmental tests for aircraft equipment: Part I General', shall apply.

6.1 Test Chamber — The chambers used for the test shall be capable of providing the conditions stated.

The temperature in the chamber shall be monitored by a temperature sensing device located within the working space at a point representative of the conditions within the rest of the chamber. The air in the chamber shall therefore be continuously circulated, but not so vigorously as to cause undue cooling of the equipment under test.

The heat source of the chambers shall not be capable of radiating heat directly on to the equipment under test.

The conditions created in the working space of the chamber shall be capable of being maintained within the tolerances specified in IS: 8252 (Part I)-1976.

6.2 Equipment Temperature — Where practicable during all high-temperature tests, temperature sensors shall be fitted to all components and assemblies that are known to be near their limiting temperatures. The temperatures at these locations shall be monitored and recorded throughout each test.

6.3 Temperature Stabilization — Stabilization will have been reached when the temperature, usually of the largest thermal mass, of the equipment is within 3°C of the final temperature. In cases where it is impracticable to determine the internal temperature by this means, the relevant equipment specification may permit the assumption of temperature stabilization after 3h operation or exposure at the specified temperature.

For non-heat-dissipating specimens the final temperature will be the mean (in time) temperature of the chamber in which the specimen is placed.

For heat-dissipating specimens it is necessary to make repeated measurements to ascertain the interval of time required for the temperature to change by 3°C, or as otherwise prescribed by the relevant equipment specification. Temperature stability has been reached when the ratio between two consecutive time intervals exceeds 1.7.

Note 1 — Where the thermal time constant of the specimen is short compared with the duration of the exposure to a given temperature, no measurement is needed.

Note 2 — It may not be possible in practice to make direct measurements of the internal temperature of the specimen. A check may then be made by measuring some other parameter which is temperature dependent and of which the temperature dependence is known.

6.4 Ambient Temperature — The ambient temperature specified in the following tests for power-dissipating equipment shall be determined in either of the following ways, as agreed with the approving or inspecting authority:

- a) By measuring the test chamber temperature using a sensor located upstream of the equipment in an airflow having a velocity not exceeding 1.0 m/s (3.3 ft/s);
- b) By determining a temperature which is based upon the surface temperature of a specified part of the equipment under test.

Method (b) would normally apply to heat-dissipating equipment installed in zones of an aircraft where there is little or no air movement and where the air movement involved in method (a) would result in cooling unrepresentative of the aircraft installation.

6.5 Equipment Requiring Air Cooling — The temperature conditions given in Table 2 are applicable to natural convection cooled equipment. The relevant specification for equipment requiring forced air cooling shall state the means of simulating the cooling arrangements, together with the mean air flow and cooling air temperature relative to each test condition.

6.6 Mounting of Equipment in Test Chamber — The mounting of the equipment in the test chamber shall simulate as closely as practicable the installation arrangement existing in normal use. Unnatural structural frames, abnormal orientation, unnatural thermal screening, etc, can all influence the behaviour of the equipment under test and these effects shall be minimized. Where equipment is supplied with cooling air, care shall be taken to ensure that the chamber conditions are not adversely affected.

6.7 Initial Performance Test — Prior to any test or sequence of tests, the equipment should be operated under the standard atmospheric conditions recommended in IS : 8252 (Part I)-1976, and shall be visually inspected and electrically and mechanically checked, as required by the relevant equipment specification. Where practicable, these checks shall be made when the equipment has been set up in the chamber ready for test.

6.8 Performance Test — A performance test shall be conducted in the manner stated in the relevant equipment specification during and/or after each environmental procedure. A performance test includes a functional test on the equipment and a visual inspection to assess structural condition, corrosion, or deterioration likely to impair future performance.

7. Test Procedures — The selection of the temperature/altitude category and corresponding degree of severity (see Table 2 and 4 and 5.1) depends on the class of aircraft and its maximum operating altitude and on the location of the equipment (in a temperature- or pressure-controlled/non-controlled area, or in the power plant compartment).

Clauses 7.1 to 7.6 describe basic tests, this is, altitude and high and low temperature. Clauses 7.7 to 7.10 describe combined test. The appropriate tests shall be invoked by the relevant equipment specification. The individual tests are graphically summarized in figures 1 to 10.

The decompression and overpressure tests (mentioned in Table 2) are applicable to Category A1 and A2 equipment only; the test procedures for these conditions are specified in IS : 8252 (Part XI)-1976 'Environmental tests for aircraft equipment: Part XI Differential pressure'.

The end use of the equipment must be taken into consideration by the equipment designer in selecting the appropriate requirements.

The order of the test is not important, and for convenience the test may be grouped so as to allow completion of those requiring the same facility (for example, high temperature group).

7.1 Altitude Test — This test (summarized in Fig. 1) simulates only the effects of low air pressure. In situations where the performance of the equipment may be adversely affected by the combination of high or low temperature with low air pressure, this test shall be supplemented or replaced by those specified in 7.8 and/or 7.9, as appropriate.

7.1.1 Test Procedure — Unless otherwise specified the equipment shall be operated at its most adverse duty cycle representative of operating conditions. The test shall be conducted with the ambient temperature within the range of standard laboratory conditions specified in IS : 8252 (Part I)-1976. The equivalent altitude within the chamber shall be increased at an average rate between 200 and 1 000 m/min (600 and 3 000 ft per minute) to that corresponding to altitudes appropriate to the equipment category, see Table 2, and shall be maintained at that altitude for a period of 30 min or as specified.

The functional performance of the equipment, if appropriate, shall be demonstrated as required by the relevant equipment specification.

While the equipment is still operating the equivalent altitude shall be restored to that corresponding to standard laboratory conditions at an average rate between 200 and 1 000 m/min (600 and 3 000 ft/min).

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7.2 Low Temperature Survival Test — This test (summarized in Fig. 2) demonstrates that an equipment is capable of withstanding, without damage, the low temperature conditions occurring when an aircraft is standing idle on the ground in a cold climate. The test also covers exposure to low temperature which may arise when equipment is transported by air in an unheated cargo bay. Equipment is not normally expected to operate in these conditions but should survive without damage.

The specified temperature of -55°C covers deployment into Arctic regions; where operation in these regions is excluded. The specification may amend the requirement to -40°C for equipment in Categories A1, A2, B1, B2 or B3.

Note — The survival temperature has been limited to -55°C to comply with the normal lower temperature imposed by some of the materials (for example, elastomers) widely used in aircraft. Conditions more severe may occur infrequently in isolated regions. If deployment into these conditions is anticipated the limitations must be declared or the test extended to -60°C .

7.2.1 Test procedure — The equipment in its idle state shall be subjected to the appropriate low temperature, selected from Table 2, until temperature stabilization is achieved and then maintained under these conditions for a further 2h.

Unless otherwise stated, the equipment shall not be operated during the test, and shall, if possible, be visually examined towards the end of the temperature conditioning period to determine whether deterioration likely to impair future performance has occurred.

If required by the relevant specification, the equipment shall be examined visually, or performance tested, after regaining room temperature. Otherwise, the equipment should be immediately subjected to the low temperature operate test described in 7.3 or the low temperature (short term) operate test described in 7.7 whichever is appropriate.

7.3 Low Temperature Operate Test — This test (summarized in Fig. 3) demonstrates that an equipment can be brought into an operational state and will continue to operate when conditioned to the low temperature that can arise on the ground or in flight.

For equipment whose operation may be initiated while the equipment is at the temperature corresponding to the low temperature survival level (7.2), this test shall be preceded by the low temperature (short term) operate test described in 7.7.

Where low pressure in combination with low temperature could influence the performance of the equipment, this test may need to be supplemented by the low temperature/low pressure test described in 7.8.

7.3.1 Test procedure — The equipment in its idle state shall be subjected to the appropriate temperature selected from Table 2, until temperature stabilization is achieved. This test, if convenient, may immediately follow the low temperature survival test described in 7.2. The equipment shall be operated with the supplies and services, as stated in the relevant equipment specification.

The relevant equipment specification shall also state any warm-up procedure, acceptable into operation times, and whether short-term derangement is acceptable. At the end of the stated warm-up period a performance test shall be made. Unless otherwise stated in the relevant equipment specification the test shall continue for either 15 min or until the performance tests have been completed whichever is the longer (see Note 1).

Note 1 — Ideally, all measurements should be made simultaneously at the end of the warm-up period. Where this is impracticable, characteristics that are likely to be affected by low temperature should be checked first. Should these checks take such a time that the state of equipment is no longer representative of that at the end of the warm-up period, the operation of the equipment should be stopped after 15 min and the temperature restabilized to the specified level (the performance test/temperature restabilizing sequence as defined above); this procedure should be repeated until the performance tests have been completed.

Note 2 — 'Warm-up' in this context does not necessarily imply artificial heating, but the time allowed to bring the equipment into operation within specified performance tolerance.

7.4 High Temperature Survival Test — This test (summarized in Fig. 4) applies to all aircraft, irrespective of classification, and simulates the maximum temperature likely to arise in an aircraft in a hot dry tropical climate (for example, Middle East, North Africa, etc). Pending the preparation of a test procedure for solar radiation, this test may also be used to simulate the temperature condition that may arise when the equipment is removed from the aircraft and exposed to direct solar radiation.

The equipment is not required, to operate during this test but merely to survive without damage.

7.4.1 Test procedure — The equipment in its idle state shall be subjected to the appropriate temperature selected from Table 2, until temperature stabilization is achieved and then maintained under the conditions for a further 30 min.

If possible, the equipment shall be visually examined towards the end of the temperature conditioning period to determine whether deterioration likely to impair future performance has occurred.

The temperature shall be reduced to that required by the high temperature (short term) operate test described in 7.5.

7.5 High Temperature (Short Term) Operate Test — This test (summarized in Fig. 5) simulates the maximum temperature conditions in which an equipment could be operated, for example, immediately following a ground soak condition. In some locations these temperature conditions would be of short duration, since the atmosphere inside the aircraft would be disturbed by opening canopies, circulation of cooling air, etc. The test requires that the equipment be capable of being operated for a short period.

Note — If the short term and the long term operating temperatures are the same, the short term operating temperature test need not be conducted.

7.5.1 Test procedure — The equipment in its idle state, with all supplies services connected, shall be subjected to the appropriate temperature selected from Table 2, until temperature stabilization is achieved. The equipment shall then be operated and its performance checked, as required by the relevant equipment specification (see Note), the chamber temperature being maintained at the specified level. The equipment shall be operated either for 30 min or until a performance test has been completed, whichever is the longer. Where the performance test takes longer than 30 min and the temperature rise of the equipment is excessive, the tests may be divided in groups, each group being made after the equipment temperature has restabilized at the chamber temperature.

If required by the relevant equipment specification, at the completion of the performance test or after the 30 min period, the operation of the equipment should be stopped for 5 min, the chamber temperature being maintained at the stated level. The equipment should then again be operated and its performance checked for a minimum period sufficient to demonstrate that it is not deranged by a hot switch-on or start-up.

Note — In determining the level of performance required during this period of test, for example, some limited degradation the operational requirements of the particular equipment or systems must be considered.

7.6 High Temperature (Long Term) Operate Test — This test (summarized in Fig. 6) simulates the maximum operating temperature to which equipment may be subjected for long periods, either on the ground or in flight.

When the performance of an equipment may be affected in flight by high temperature combined with low air pressure this test must be supplemented by the test described in 7.9.

7.6.1 Test procedure — The equipment in its idle state, with all supplies and services connected, shall be subjected to the appropriate temperature selected from Table 2, until temperature stabilization has been achieved. The equipment shall then be operated for a period of 2h, or as stated in the relevant equipment specification, the chamber temperature being maintained at the specified level. Towards the end of this operate period, preferably after internal temperatures of heat dissipating equipment have restabilized, the equipment shall be subjected to a performance test.

If required by the relevant equipment specification the operation of the equipment shall then be stopped for 5 min, while the chamber temperature is maintained at the specified level. The equipment shall then be operated and a limited performance check made, only to demonstrate that it is not deranged by a hot switch-on or start-up.

7.7 Low Temperature (Short Term) Operate Test — This test (summarized in Fig. 7) demonstrates that an equipment will not suffer damage or permanent derangement if operated or switched-on immediately following a low temperature soak and before the aircraft conditioning system has become fully effective. It should only be invoked when the equipment is at risk to this type of operation.

The specified temperature of -55°C covers deployment into arctic regions; where operation in these regions is excluded, the national specification may relax the requirements to -40°C for equipment in Categories A1, A2, B1, B2 and B3.

7.7.1 Test procedure — For convenience, this test can be conducted following the low temperature survival test described in 7.2 and shall precede the low temperature operate test in 7.3.

The equipment in its idle state, with all supplies and services connected, shall be subjected to the appropriate temperature selected from Table 2, until temperature stabilization has been achieved. The equipment shall then be operated for a period of 15 min (see Note 1), the chamber temperature being maintained at the specified level. The equipment shall not suffer deterioration likely to impair future performance; the functional performance required shall, if appropriate, be stated in the relevant equipment specification (see Note 3).

Note 1 — Ideally, all measurements should be made simultaneously at the end of the warm-up period. Where this is impracticable, characteristics that are likely to be affected by low temperature should be checked first. Should these checks take such a time that the state of the equipment is no longer representative of that at the end of the warm-up period, the operation of the equipment should be stopped after 15 min and the temperature restabilized to the specified level (the performance test/temperature restabilizing sequence as defined above); this procedure should be repeated until the performance tests have been completed.

Note 2 — Warm-up in this context does not necessarily imply artificial heating, but the time allowed to bring the equipment into operation within specified performance tolerances.

Note 3 — In determining the level of performance to be required during this test, for example, some limited degradation the operational requirements of the particular equipment or system must be considered.

7.8 Low Temperature/Low Pressure Test — This test (summarized in Fig. 8) simulates the lowest operational temperature that is likely to occur under flight conditions up to maximum operational altitudes.

Although the test simulates a realistic flight condition, it need not necessarily be applied in all cases; for example, where the low-temperature conditioning is adequately covered by the low temperature operate test described in 7.3, the effects of altitude can be ignored.

The test must be applied, however, if test methods 1 or 2 of the temperature/humidity sequence of 7.10 are invoked.

The test is essential where the effects of a pressure differential could accentuate potential defects arising from low temperature, as in a sealed equipment, although in equipment of this type it may be permitted to demonstrate sealing standards by simulating the pressure differential, if the failure mechanism is known, by increasing the positive internal pressure within the equipment.

The temperatures given in Table 2 for equipment Categories E1 and E2 apply to normal aircraft usage. Certification tests on equipments that are to be used in the aircraft during development flying, the test may need to be carried out at -70°C . A temperature of -70°C can result from reduced kinetic heat effects during stalling trials on development aircraft. The individual equipment specification shall state whether this is additional to, or instead of, the test procedure specified in 7.8.1.

7.8.1 Test procedure — The equipment shall be subjected to the appropriate temperature selected from Table 2, until temperature stabilization is achieved. The pressure should then be adjusted to the level specified for the altitude test described in 7.1.

The rates of change of pressure shall be those specified for the altitude test given in 7.1.1. Unless otherwise specified the equipment shall then be given a hot switch-on or start-up as specified in 7.5.1.

The equipment shall be operated as required by the relevant equipment specification, the chamber temperature being maintained at the specified level (equipment normally operated throughout flight may be operated from the start of the temperature conditioning and shall continue to operate throughout the test). The relevant equipment specification shall require the operation of the equipment to be stopped during the temperature/altitude conditioning phase until internal temperatures have restabilized so that a subsequent cold switch-on or start-up can be made.

Equipment that is operated intermittently in flight shall be operated only when the equipment has stabilized at the test temperature.

The equipment shall also be subjected to a performance test as required by the relevant equipment specification. The temperature/pressure conditioning shall continue for at least 30 min after the equipment has commenced functioning or until the performance test is completed, whichever is the longer (see Note).

Note — Ideally, all measurements should be made simultaneously at the end of the warm-up period. Where this is impracticable, characteristics that are likely to be affected by low temperature should be checked first. Should these checks take such a time that the state of the equipment is no longer representative of that at the end of the warm-up period, the operation of the equipment should be stopped after 15 min and the temperature re-established to the specified level (the performance test/temperature restabilizing sequence as defined above). This procedure should be repeated until the performance tests have been completed.

7.9 High Temperature/Low Pressure Test — This test (summarized in Fig. 9) simulates the combination of temperature/altitude conditions at the ceiling altitude of the particular class of aircraft.

The levels given for equipment Category A, stated in Table 2, are derived on an arbitrary basis and are estimated to be the maximum levels that could occur in semi-stagnant areas within the particular temperature controlled region (for example, in an enclosed space behind an electronic unit).

7.9.1 Test procedure — The equipment, in its idle state, shall be subjected to the appropriate temperature selected from Table 2 until temperature stabilization has been achieved. The pressure shall then be reduced to the specified level. The equipment shall be operated for a period of 2h, unless otherwise required by the relevant equipment specification, the chamber temperature being maintained at the specified level. Towards the end of this period it shall be subjected to a performance test.

The rates of change of pressure shall be those specified for the altitude test given in 7.1.1. Unless otherwise specified, the equipment shall then be given a hot switch-on or start-up as specified in 7.5.1.

7.10 Temperature/Pressure/Humidity Sequence Test — This test (summarized in Fig. 10) simulates the conditions of moisture breathing condensation which can occur when an aircraft descends from a cold atmosphere. The resulting surface moisture may be significant in electrical circuits, particularly in partially

closed equipment when the condensation and breathing effect produces a build-up of free water inside the equipment.

It should be noted that this test may not necessarily reveal defects arising from prolonged exposure to a tropical damp environment; in such instances the humidity test specified in IS : 8252 (Part III)-1978 'Environmental tests for aircraft equipment: Part III Humidity (24-hour cycle)' should be applied.

Where local ice formation may be a hazard (for example, through the failure of normally open contacts to close a circuit when required to do so) reference should be made to the icing tests covered in IS : 8252 (Part IV)-1980 'Environmental tests for aircraft equipment: Part IV Ice formation'.

The appropriate test method shall be selected from the following and shall be stated in the relevant equipment specification :

Method 1 — Applies to items whose performance could be immediately and adversely affected by moisture condensation. The method is particularly applicable to equipment of an enclosed or partially sealed construction, where the pressure change due to altitude arising from one flight descent phase could induce the ingress of moisture.

Method 2 — Applies to equipment, or equipment containing items, of enclosed or partially sealed construction where the cumulative effects of condensation over a number of flight descents would be needed to adversely affect the performance of the equipment.

Method 3 — Applies to items of open construction whose performance could immediately and adversely be affected by moisture condensation, but where the pressure changes due to altitude would be of little significance.

Note — Method 2 should always be invoked in instances when it is not clear which method is appropriate.

7.10.1 Test procedure (Method 1) — This test shall immediately follow the low temperature/low pressure test described in 7.8. The chamber temperature shall be raised from the level of that test to $+30^{\circ}\text{C}$ in a period of 1 to 2h with the same test conditions prevailing and with the humidity held at or close to saturation (nominally not less than 95 percent). It is important that visible frosting or condensation occurs on the surface of the equipment unless this is prevented by self-generated heat from the equipment. The pressure shall be restored to that corresponding to ground level at an approximately uniform rate during a period 15 to 30 min when the mean equipment temperature has attained a level of between 0°C and 5°C and frost which may have formed has melted.

Alternatively the chamber temperature and pressure shall be raised to $+30^{\circ}\text{C}$ at an approximately uniform rate in such a way that in a period of 1 to $1\frac{1}{2}$ h the mean equipment temperature reaches a level between 0 to 50°C and the frost which may have formed melts. The temperature and humidity shall then be stabilized at $+30^{\circ}\text{C}$ and 95 percent RH.

In case a combined temperature—pressure—humidity chamber is not available and unless otherwise required by the relevant equipment specification, it is permissible to transfer the equipment to the humidity chamber from the low temperature—pressure chamber and *vice versa* under normal laboratory conditions in less than 15 minutes.

The equipment shall be operated as required by the relevant equipment specification. Equipment intended for operation throughout the descent phase shall operate throughout the test. Unless required by the relevant equipment specification, equipment normally idle during the descent phase should not be operated until the equipment temperature has stabilized at $+30^{\circ}\text{C}$. In either case the test shall continue for 1h after the temperature and humidity have stabilized at $+30^{\circ}\text{C}$ and 95 percent RH, or for a period sufficiently long to make a performance test, whichever is longer.

7.10.2 Test procedure (Method 2) — After completing the test by Method 1, the equipment shall be reconditioned to the appropriate levels of temperature and pressure specified in 7.8.1 to constitute 1 cycle. This combined procedure shall be repeated for a total of 4 cycles, or such number of cycles as is stated in the relevant equipment specification. The equipment under test shall also be operated as stated in the relevant equipment specification. At the completion of this test the equipment shall be allowed to return to normal laboratory conditions. The relevant equipment specification will state the degree of disassembly necessary prior to examination of the equipment for ingress of moisture.

7.10.3 Test procedure (Method 3) — This test method shall be selected from either of the following two alternatives. It can immediately follow the low temperature test described in 7.3. It is essential that, whichever procedure is adopted, condensation shall occur on the equipment, unless prevented by self-generated heat from the equipment.

- a) The equipment, conditioned to the appropriate low temperature specified in 7.3.1, should be transferred to a humidity cabinet held at a temperature of 30°C and humidity not less than 95

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percent RH as quickly as possible, but in a time not exceeding 15 min, this latter period applying only to complex equipment involving problems in handling.

- b) It is also permitted to use one chamber and to introduce such heating and humidity that the chamber temperature is raised from the appropriate low temperature level to +30°C in 1 to 2h. During this transitional period the humidity shall be held close to saturation (nominally not less than 95 percent RH*).

In either case the equipment shall be operated for 1h after the temperature has stabilized at +30°C or for period sufficiently long to carry out a performance test, whichever is the longer. The equipment shall be operated as required by the relevant equipment specification. If it is required that the equipment should operate during the simulated descent phase, then Method 3(b) would apply.

7.11 Metric equivalents of the altitudes and corresponding atmospheric pressure are given in Table 3.

TABLE 1 SUMMARY OF EQUIPMENT CATEGORIES AND AIRCRAFT CLASSIFICATIONS

(Clause 5)

Equipment Category	Aircraft Class	Equivalent Altitude	Location		
			Pressurized	Temperature Conditioned	Power Plant
A1 A2	X, Y or Z	4 500 m (15 000 ft)	Yes Yes	Yes No	No No
B1 B2 B3	X	6 000 m (20 000 ft)	No No No	Yes No No	No No Yes
C1 C2 C3	Y	10 500 m (35 000 ft)	No No No	Yes No No	No No Yes
D1 D2 D3	Y	15 000 m (50 000 ft)	No No No	Yes No No	No No Yes
E1 E2	Z	21 000 m (70 000 ft)	No No	No No	No Yes

*A saturated atmosphere conforming to these requirements will be accepted without humidity measurement if heating is by steam injection.

TABLE 2 TEMPERATURE AND PRESSURE REQUIREMENTS
(Clauses 5, 6.5, 7, 7.1.1, 7.2.1, 7.3.1, 7.4.1, 7.5.1, 7.6.1, 7.7.1, 7.8, 7.8.1, 7.9 and 7.9.1)

Equipment Category	Altitude Test (7.1)	Low Temperature		High Temperature			Low Temperature		High Temperature Low Pressure Test (7.9)	Temperature/Pressure/Humidity Sequence Test (7.10)	Differential Pressure	
		Survival Test (7.2)	Operate Test (7.3)	Survival Test (7.4)	(Short Term) Operate Test (7.5)	(Long Term) Operate Test (7.6)	(Short Term) Operate Test (7.7)	Low Pressure Test (7.8)			Decompression Test	Over Pressure Test
	× 1 000 m	°C	°C	°C	°C	°C	°C	°C/× 1 000 m	°C/× 1,000 m	Use test conditions from col 9 (or col 4, if appropriate) and change to the humidification conditioning—Methods 1, 2 or 3 (sub-clauses 7.10.1, 7.10.2 or 7.10.3)	Refer to : IS : 8252 (Part XI) - 1976*	
A1	4.5	−55 (Note 1)	−15	+85	+70	+55	−55 (Note 1)	−15/4.5	+45/4.5		Not applicable	Not applicable
A2	4.5	−55 (Note 1)	−15	+85	NA	+70	−55 (Note 1)	−15/4.5	+45/4.5†			
B1	6	−55 (Note 1)	−15	+85	+70	+55	−55 (Note 1)	−15/6	+45/6			
B2	6	−55 (Note 1)	−40	+85	NA	+70	−55 (Note 1)	−40/6	+20/6			
B3	6	−55 (Note 1)	−40	see Note 3	see Note 3	see Note 3	−55 (Note 1)	−40/6	see Note 3 /6			
C1	10.5	−55	−20	+85	+70	+55	−55	−20/10.5	+35/10.5			
C2	10.5	−55	−55	+85	NA	+70	↑	−55/10.5	+20/10.5			
C3	10.5	−55	−55	see Note 3	see Note 3	see Note 3	Not applicable	−55/10.5	see Note 3 /10.5			
D1	15	−55	−20	+85	+70	+55	Not applicable	+20/15	+20/15			
D2	15	−55	−55	+85	NA	+70		−55/15	+20/15			
D3	15	−55	−55	see Note 3	see Note 3	see Note 3		−55/15	see Note 3 /15			
E1	21	−55	−55	+85	see Note 2	see Note 2	Not applicable	−55/21‡	see Note 2 /21			
E2	21	−55	−55	see Note 3	see Note 3	see Note 3		−55/21‡	see Note 3 /21			

Note 1 — The low temperature survival requirements for categories A and B equipment may be relaxed to −40°C (see 7.2 and 7.7).

Note 2 — The high temperature operated requirements, both long and short term, for Category E1 equipment cannot be standardized since the temperature attained will depend upon heating parameters related to the equipment bay; the temperature requirements will need to be specified in the relevant equipment specification.

Note 3 — The conditions may vary widely depending upon the precise location of the equipment relative to the engine shroud—the requirements for those areas should be resolved in conjunction with the aircraft and engine manufacturers.

*Environmental tests for aircraft equipment, Part XI Differential pressure.

†The temperature will depend upon the precise location of the equipment and the effectiveness of the temperature conditioning. The temperature will be stated in the relevant equipment specification but would not normally exceed +70°C.

‡In special cases −70°C may apply (see 7.8).

TABLE 3 EQUIVALENT ALTITUDES AND PRESSURES

Altitude		Atmospheric Pressures*	
m†	ft (approx)	millibar	kPa (kN/m ²)
4 500	15 000	577	57.7
6 000	20 000	472	47.2
10 000	35 000	245	24.5
15 000	50 000	121	12.1
21 000	70 000	47	4.7

*These values correspond with International Standard Atmospheres (ISA).

†The altitudes in feet are approximate values of those in metres.

APPENDIX A

(Clause 2.3)

BASIS OF CLIMATIC TEMPERATURE LEVELS

A-1. Long-term meteorological records show wide variations in temperature for any given area or altitude. It is difficult, therefore, to state single figures to represent 'low' and 'high' values, and to select the most extreme recorded temperatures may force manufacturers to design to uneconomic levels.

A-2. For the tests in this Standard it has been considered reasonable that equipment should be expected to operate in atmospheric temperatures whose probability of occurrence will not exceed 5 days per year. The relevant equipment specification should prescribe more exact conditions if this probability level is unacceptable; guidance is given in Appendix B.

A-3. Although the high temperature tests, too, are based on the same 5 days per year probability, an additional margin has been added to the ground conditions to allow for the temperature rise of an aircraft due to solar radiation. Flight conditions include an allowance for kinetic heating depending upon the class of aircraft.

APPENDIX B

(Clause A-2)

TEMPERATURE CONDITIONS RELATED TO RISK

B-1. The atmospheric temperature conditions used in compiling this Standard have been based upon information published by the United Kingdom Meteorological Office.

B-1.1 Information on atmospheric temperature conditions at ground level is given in the following references:

- 1) 'Tables of temperature, relative humidity and precipitation for the world' Parts 1 to 6 inclusive, United Kingdom Meteorological Office publication references MET 0-617(a) to (f) inclusive.
- 2) 'Air temperature and its variability' by L. Dods and F.E. Dinsdale, Meteorological Office Investigation Division Memo No. 96 dated 1964.

B-2. In addition data relating to temperature conditions at altitudes up to 30 500 m (100 000 ft) was provided by the United Kingdom Civil Aviation Authority, Airworthiness Division. The source of the data was their publication TSS Standard No. 6, issue 1—'Atmospheric conditions', a document not widely available, and has now been superseded by the document referred to in para **B-2.1** below.

B-2.1 Information regarding summer and winter distribution for a selection of altitude circles in the Northern hemisphere is given in International Standard ISO*.

*Under preparation by ISO/TC 20/SC 6.

B-3. An allowance also needs to be made for the influence of kinetic heating. For the purposes of this Standard the temperature rise of the aircraft boundary layer above atmospheric temperature, was calculated as follows:

$$t_R = 0.2 T M^2$$

where

t_R is the temperature rise of the aircraft, in degree Celsius;

T is the temperature of the atmosphere, in degree kelvins;

M is the speed of the aircraft relative to the atmosphere, expressed as Mach number.

B-3.1 At minimum temperatures the lowest flight speeds for the particular class of aircraft, were considered, while at the maximum temperatures, the highest flight speeds were taken into account.

In those cases where equipment is to be installed in bays which are subject to adiabatic wall (ram recovery) temperature, and not to the full ram temperature rise, an appropriate constant in place of 0.2 in above equation may be used. Since in many cases the equipment manufacturer has no control over these conditions, this Standard states the full ram temperature.

EXPLANATORY NOTE

This standard is one of the series of standards relating to environmental and operating conditions for aircraft equipment. The scope and applicability of this standard is given in IS : 8252 (Part I)-1976 'Environmental tests for aircraft equipment: Part I General'.

This Indian Standard is based on revised text of ISO/DIS 2651 Environmental tests for aircraft equipment—Part 2.1 Temperature, pressure and humidity, issued by International Organization for Standardization (ISO).

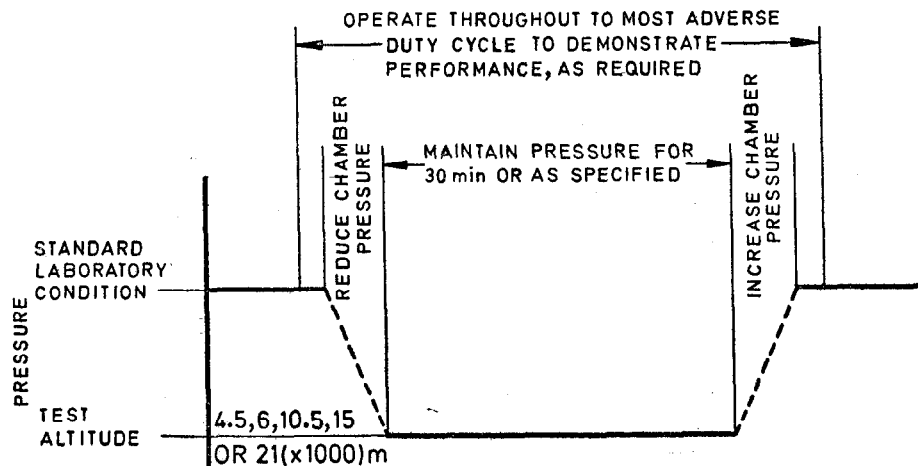


FIG. 1 ALTITUDE TEST SEQUENCE

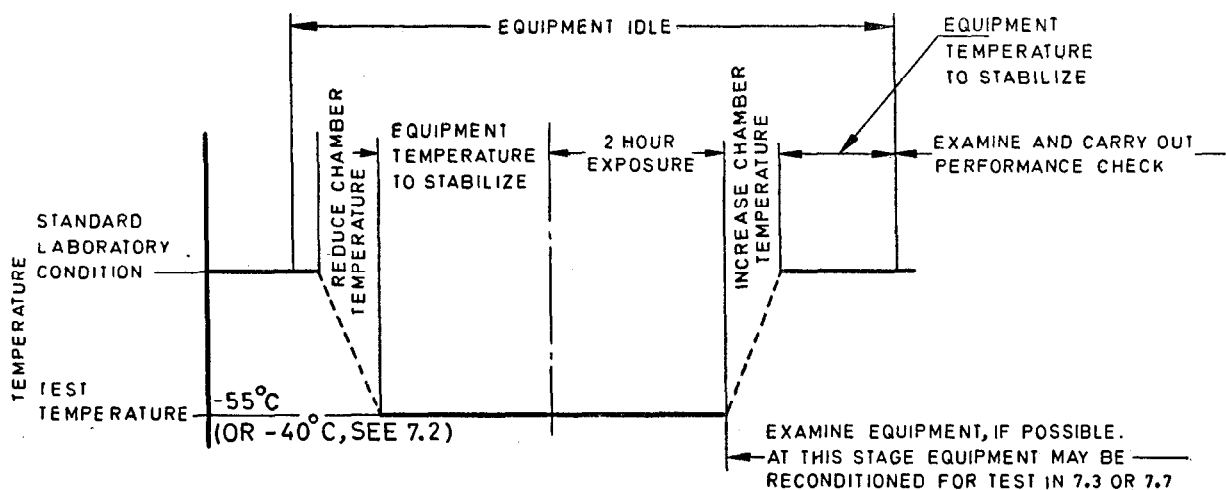
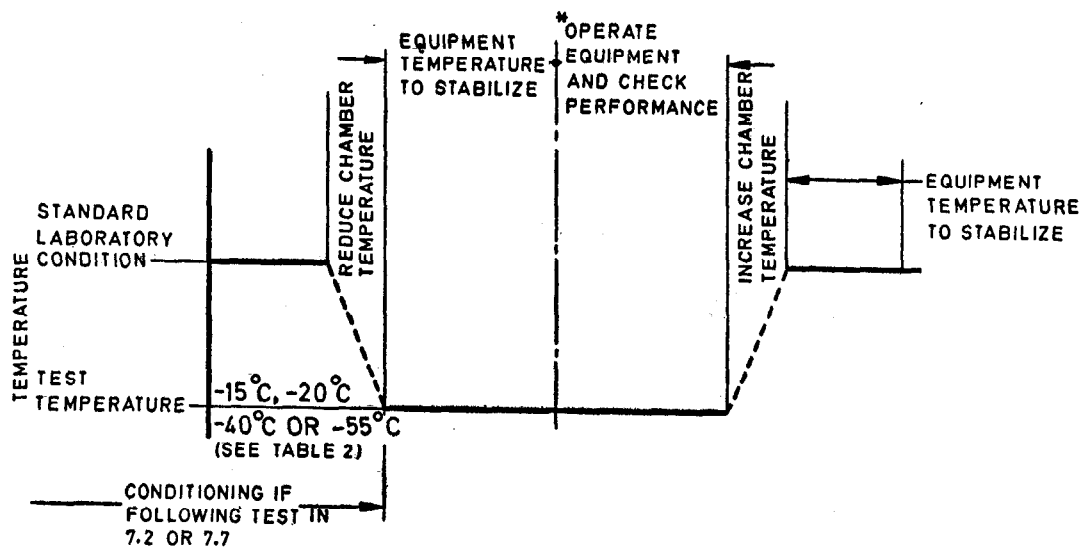


FIG. 2 LOW TEMPERATURE SURVIVAL TEST SEQUENCE



* Performance tests limited to 15 min operation followed by restabilization of equipment to test temperature until performance test is complete.

FIG. 3 LOW TEMPERATURE OPERATE TEST

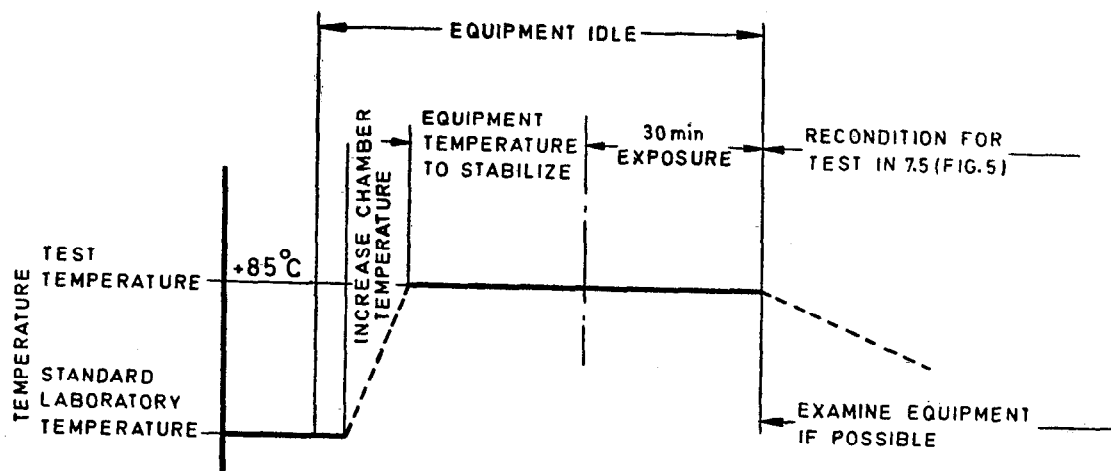
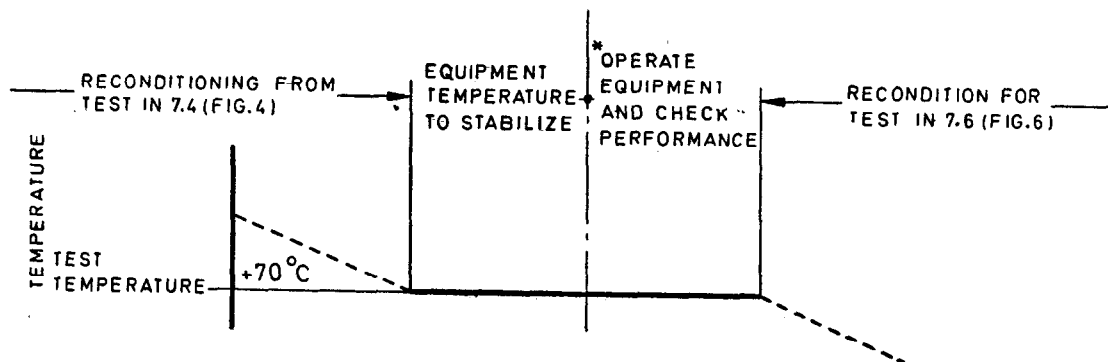


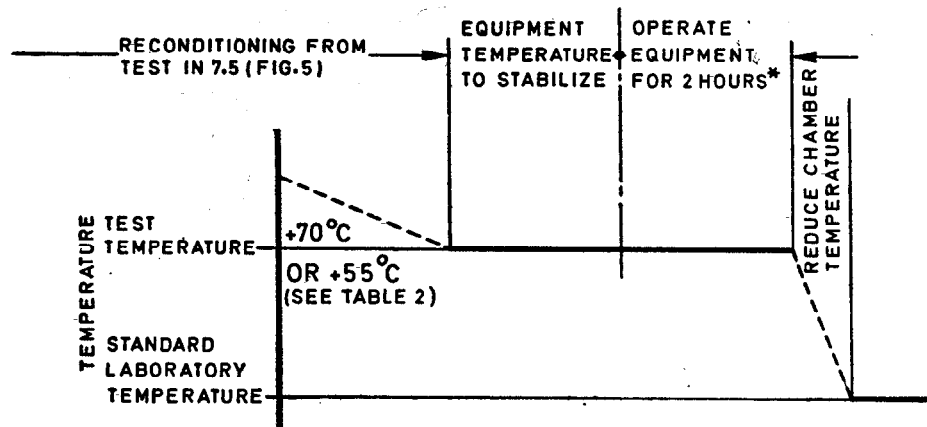
FIG. 4 HIGH TEMPERATURE SURVIVAL TEST



* When performance test extends beyond 30 min conduct the test in groups with intervening reconditioning (see 7.5.1).

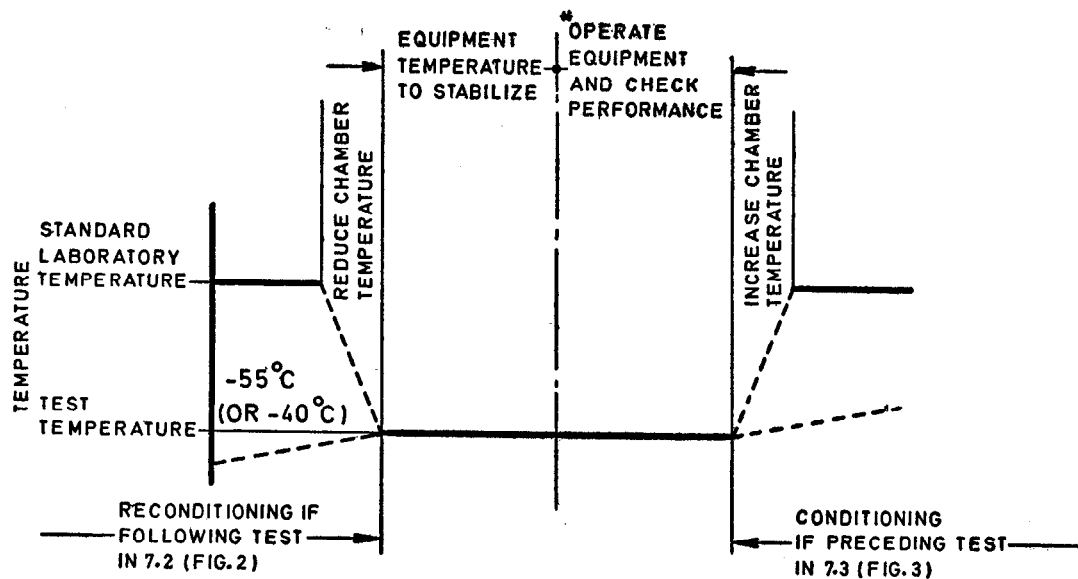
Also carry out hot switch-on or start-up.

FIG. 5 HIGH TEMPERATURE (SHORT TERM) OPERATE TEST



* Carry out performance test when equipment temperature has attained maximum level. Also carry out hot switch-on or start-up.

FIG. 6 HIGH TEMPERATURE (LONG TERM) OPERATE TEST



* Performance test limited to 15 min periods of operation followed by restabilization of equipment to test temperature until performance test is complete.

FIG. 7 LOW TEMPERATURE (SHORT TERM) OPERATE TEST

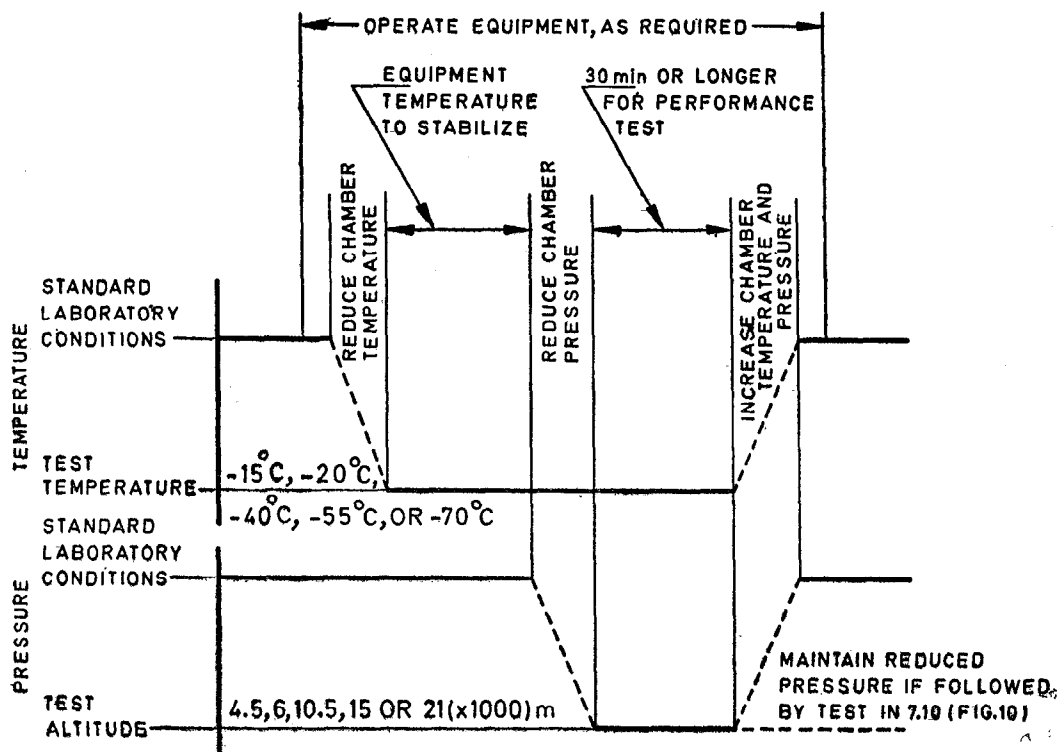
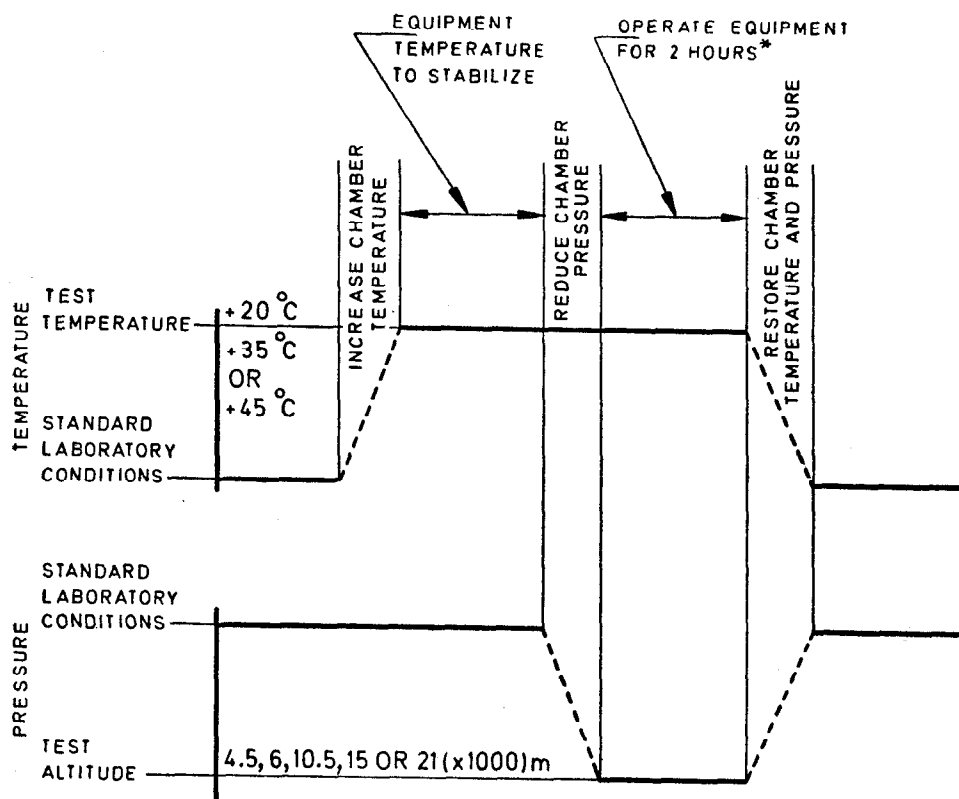


FIG. 8 LOW TEMPERATURE/LOW PRESSURE TEST



* Carry out performance test when equipment temperature has attained maximum level. Also carry out hot switch-on or start-up.

FIG. 9 HIGH TEMPERATURE/LOW PRESSURE TEST

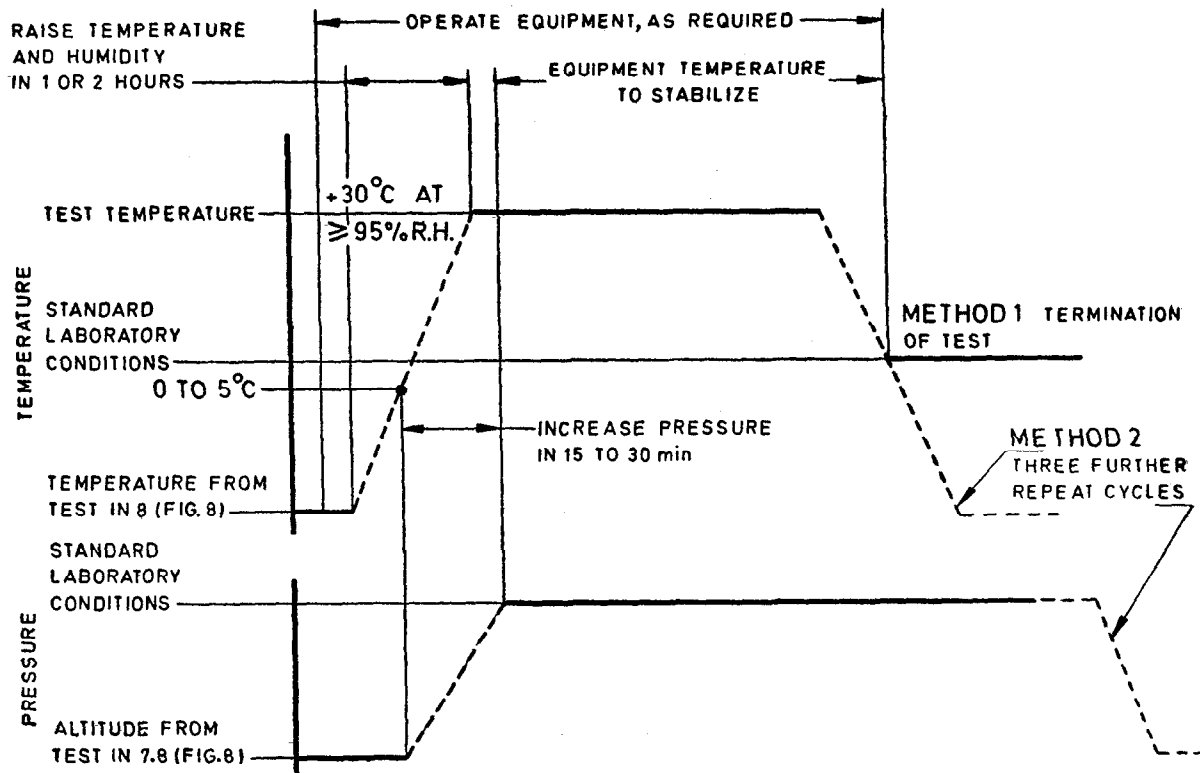


FIG. 10 TEMPERATURE/PRESSURE/HUMIDITY TEST